Hybrid Total Knee Arthroplasty

13-year Survivorship of AGC Total Knee Systems with Average 7 Years Followup

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Abstract A retrospective study of 201 anatomic graduated component total knee arthroplasties implanted with hybrid fixation at the authors' center was performed in response to conflicting data in the literature concerning the benefits of a hybrid method. Selection for hybrid fixation was nonrandomized and based on femoral component fit. Survivorship analysis was performed, and rates of radiolucent lines surrounding the femoral component and occurrence of osteolysis were noted. At 7 and 13 years, survivorship with tibial or femoral revision as the end point was 0.9926 and 0.9732, respectively. Radiolucencies were found adjacent to 15 femoral components at final followup (seven in Zone 1, three in Zone 2, five in Zone 3, one in Zone 4, two in Zone 5, zero in Zone 6). Osteolysis was observed in one knee after secondary evaluation. Hybrid fixation in a selected patient population can result in excellent results in middle to long-term followup.

Level of Evidence: Level IV, prognostic study. See the Guidelines for Authors for a complete description of levels of evidence.

Introduction

Despite small, but prevalent, incidences of osteolysis [1, 9, 16, 26, 31, 36, 37, 47, 50, 56, 57] (ranging from 4.1% to 34%), polyethylene wear [10, 14, 15, 32, 38, 41, 53, 55], and lack of adequate fixation [3, 7, 33, 52, 54], TKA is a highly successful operation with success rates greater than 90% [4, 12, 17–19, 24, 36, 39, 40, 43, 45, 48, 51]. To further minimize the aforementioned concerns that lead to TKA failure, various fixation methods have been proposed [2, 5, 21] and used. Cementless fixation with porous coating has largely met with mixed results [8, 11, 12, 13, 17, 19, 20, 27, 39, 40], including a 15-year survival of 72% [13] and greater loosening among uncemented tibial components compared with cemented components [7]. In contrast, short-term studies of hybrid fixation showed promise for this second alternative [23, 28, 30, 49, 58]. However, one intermediate-term report [6] of 65 press-fit condylar (PFC) arthroplasties had unacceptable implant survivorship (89% after 5 years, 85% after 8 years) and problems with the femoral component. These problems included six of nine revisions for a loose femoral prosthesis, two of nine for a fractured femoral prosthesis, and one for osteolysis, which led the authors of the study to recommend abandonment of hybrid TKA.

Because of this conflict of data, we examined the results of a nonrandomized study of the survivorship of hybrid TKA. In our long-term study performed over a minimum of 2.0 years (average, 7.9 years; range, 2.0–17.4 years), we examined the clinical and survivorship results of 201 hybrid TKAs using one design.

Materials and Methods

Of 403 TKAs performed at our institution between August 24, 1988, and May 17, 1989, 201 (49.9%) were hybrid

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Each author certifies that his or her institution has approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

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fixation TKAs, all of which used anatomic graduated components (AGC; Biomet, Warsaw, IN). The femoral component consisted of a cobalt-chrome articular surface with a plasma-sprayed titanium undersurface, including anterior, posterior, distal, and chamfer surfaces. The pegs were poly grit-blasted. The patellae were all polyethylene, single-pegged, and the tibial component was a monoblock titanium-backed component. No other hybrid procedures were performed after the study period.

The study group comprised 80 women (61.1%) and 51 men (38.9%). Seventy patients (34.8%) received bilateral hybrid arthroplasties; five others received bilateral arthroplasties with one knee implanted with hybrid fixation. The average age of the patients at the time of surgery was 70.3 ± 8.1 years (mean $\pm$ standard deviation; range, 44–87 years). The average body mass index at the time of surgery was 27.0 ± 4.3 kg/m² (range, 17.4–39.6 kg/m²). Diagnoses in this group were osteoarthritis in 181 knees (90.0%), rheumatoid arthritis in 12 (6.0%), osteonecrosis in seven (3.5%), and Paget's disease in one (0.5%). The preoperative Knee Society score was 51.6 ± 13.7 (range, 7–81); preoperative function score was 49.9 ± 15.8 (range, 10–90); and preoperative pain score was 29.5 ± 11.0 (range, 0–50). Of patients who did not receive hybrid components during the study period, 83 were women (69%) and 37 were men (31%). Their average age at the time of surgery was 73 ± 8.0 years (range, 50–90 years), and their average body mass index was 29.2 ± 5.6 kg/m² (range, 19.4–48.9 kg/m²).

During the study period, we performed 202 all cemented AGC TKAs. Selection for hybrid TKA was based on surgeon preference taking into account the coaptation of the implant; once the trial femoral component was implanted, the patient received a hybrid prosthesis if the performing surgeon determined that it fit snugly. Cement was used as the primary method of fixation in all tibial and patellar components, and the posterior cruciate ligament (PCL) was retained in all patients. We used screws in conjunction with cement in six tibial components to help fill large defects [42, 44, 46], and the keel was cemented.

We evaluated all patients preoperatively, at 6 months, and at 1, 3, 5, 7, 10, 12, 15, and 17 years after surgery, when available. Patient evaluation spanned an average of 7.9 ± 4.9 years (range, 2.0–17.4 years). Radiographs were taken 2 months postoperatively and at every subsequent followup. Radiographs were evaluated at followup by the performing surgeon, who was not blinded, for varus-valgus alignment and occurrence of radiolucent lines. Primary evaluation of osteolysis, using the definition given by Peters et al. [37], was performed after the study period by two of the authors (PMF, ATF) involved in the study who were not blinded to patient identification; a secondary detailed evaluation of possible osteolysis was performed by

another author (MAR), who also was not blinded to patient identification. Failure was defined as revision of the femoral or tibial component for reasons other than infection.

We performed statistical analysis using SAS statistical software (SAS Institute, Inc, Cary, NC). Survivorship rates were obtained with Kaplan-Meier survival analysis [25] with failure defined as revision of the tibial or femoral component.

Results

Kaplan-Meier survival analysis, with failure defined as revision of either the femoral or tibial component, found that at 5 years, the followup survival rate was 1.0000; at 7, 10, and 12 years followup, the survival rate was 0.9926; and at 13 years followup, the survival rate was 0.9732 (Fig. 1). Preoperative knee scores improved from an average score of 50 to 95 at 1 year followup with similar improvements in functional scores (Fig. 2).

During the followup period, there were five revisions of the femoral or tibial component (2.5%), two of which were not related to an infection (two of 201 [1.0%]). Both aseptic revisions resulted from medial tibial collapse secondary to loosening, and both knee systems had a well-fixed femoral component at revision. The aseptic revisions included one in a 70-year-old man and one in a 65-year-old woman; both were treated primarily for osteoarthritis. The two tibial components were in 90° coronal alignment; the overall anatomic alignment for one knee was in 5° valgus, whereas the other was 0°. Both patients had a pain score of 50.

There were three knees (two tibial components, discussed previously, and one femur) that were considered radiographically loose. The loose femoral component, in a 62-year-old man treated for osteoarthritis, did not require revision; the overall alignment was 4° valgus and 87° coronal tibial alignment. The patient had a pain score of 50. Although there were radiographic signs of loosening, there was no change in alignment or migration of the prostheses.

At final followup, we found radiolucencies adjacent to the femoral component in 15 of 194 knees (7.7%). Seven radiolucencies were found in Zone 1, three in Zone 2, five in Zone 3, one in Zone 4, two in Zone 5, and zero in Zone 6. One hundred twenty-five of 176 knees had no radiolucency at 1 year followup (71.0%), 117 of 136 had no radiolucency at 3 years (86.0%), 78 of 87 had no radiolucency at 5 years (89.7%), 54 of 59 had no radiolucency at 10 years (91.5%), and 11 of 12 had no radiolucency at 15 years (91.7%). Radiolucencies greater than 2 mm at earlier followup, typically found around the anterior or posterior femoral flanges, did not increase in size or compromise the implant; all such lucencies did not progress into adjacent zones.

Fig. 1 Kaplan-Meier survivorship analysis shows 97.3% survival at 13 years.

Fig. 2 Average knee society scores for hybrid fixation (n = 201 knees) are shown.

On primary radiographic evaluation, we found nine osteolytic lesions in eight of 201 knees (4.0%), but only one of these nine lesions (in 0.5% of 201 knees) was determined to possibly be wear osteolysis after secondary evaluation; the other eight were small, medial, and nonprogressive. Two lesions were found surrounding a femoral component, whereas the other seven were found in the tibia. One femoral lesion was located adjacent to the anterior flange with the other adjacent to the posterior flange; these were determined to be related to poor

coaptation of the femoral flanges, and not polyethylene wear, on secondary evaluation. All seven tibial lesions were found in the medial tibial plateau. Six of these appeared within 5 mm of the edge of the plateau; they first appeared at 6 months followup and were nonprogressive; thus, they were deemed nonosteolytic at secondary evaluation. The area of concern for osteolysis in the one knee with possible osteolysis after secondary evaluation was noted at 3 years followup; the area became more prominent, but it did not expand during the 15-year followup

period. One knee had two lesions that were visualized, one in the medial tibia and one in the anterior femur but both were deemed nonosteolytic. All patients with apparent osteolysis determined at primary evaluation, with the exception of those who had revision surgery, had a pain score of 50.

Three supracondylar femoral fractures occurred in the study group. These fractures, which appeared near the distal third of the right femur, were treated with Rush rods; all healed sufficiently. We performed three revision arthroplasties secondary to infection in two patients within 2 years after the index surgery; these were revised with modular Insall-Burstein constrained prostheses (Zimmer, Warsaw, IN). Seven manipulations and three lateral releases were performed. Other operations included seven manipulations, three lateral releases, and one patellar button excision.

Discussion

Cementless fixation in TKA was developed to negate the problems associated with cemented TKA; however, in light of the mixed results associated with cementless TKA [11, 12, 13, 17, 19, 20, 27, 39, 40], hybrid fixation was put forth as an alternative. In initial studies [28, 30, 49, 58], this method showed success rates comparable with those of the cemented femoral Miller-Galante and PFC components; however, the studies relied on short followup and stressed further study was warranted. Campbell et al. [6] cited 10 revisions among 65 PFC implants and 84.6% survivorship at 8 years; these findings led them to conclude hybrid fixation should be abandoned. On seeing these results and reports [22, 24, 29, 34] suggesting increased success rates could result from patient selection, we decided to examine data concerning our center's experience with hybrid TKAs.

One limitation of this study was the reliance on standard radiographs to observe osteolysis [23, 35]. However, the same two technicians took all the radiographs and their techniques are the same. Moreover, the scarcity of revisions in this study group suggests possible unobserved osteolysis did not complicate the integrity of the implants.

Previous studies [15, 20, 23, 26, 37] have found an increased incidence of osteolysis in cementless TKAs surrounding tibial and femoral components. Specifically, one study [37] found a 16% occurrence of osteolysis surrounding tibial screws in cementless TKA, and another [20] found tibial osteolysis in 24 of 113 knees (21%) and femoral osteolysis in 20 knees (18%). Osteolysis was found in fewer knees in the current study, in only one of 201 hybrid TKAs after secondary evaluation. Two knees in the group of 201 (1.0%) showed potential osteolysis around the cementless femoral component; however, they were

deemed to be a result of failed coaptation of the femoral flanges because Zones 2, 3, 4, and 6 showed femoral ingrowth. We believe the overall decreased occurrence of osteolysis is influenced by the monoblock tibial component with compression-molded polyethylene, which has been shown to have decreased wear characteristics [43].

Numerous evaluations of implant designs and fixation methods [1, 7, 12, 51, 52] have noted the constant but variable prevalence of radiolucent lines surrounding TKA components. Lucencies have been found in at least one zone adjacent to 18 of 55 (32.7%) [12] and five of 58 (8.6%) [51] cementless femoral components in cementless TKA in groups followed for an average 10 and 11 years, respectively. Two of the 55 were considered radiographically loose, whereas none of the 58 was loose at followup. In our study, we found no radiolucencies at final followup in 179 of 194 knees (92.3%), with incidence of radiolucency decreasing with each subsequent followup. Only one femoral component, which did not require revision, was deemed to be loose at clinical and radiographic followups.

Comparisons among fixation techniques in primary TKAs have been produced in studies using databases with greater than 5700 knee arthroplasties [17, 19, 39, 40]. In two of these reports [19, 40], such comparisons included the survival rates of cemented, cementless, and hybrid TKAs. Both found the survivorship of cemented components to be superior to the latter two methods, with cemented implants having success rates of 99% and 92%, respectively (Table 1). These findings give credence to cemented fixation's distinction as the gold standard against which all other fixation methods are compared. However, hybrid fixation has consistently shown more success than cementless techniques, as seen by the 97.3% 13-year success rate found in the current study. This is partly attributable to the improved surgical procedure and continued, but tempered, evolution of components.

Hybrid TKA has shown good short-term and intermediate-term results. Although cemented fixation has consistently had excellent survival rates, careful selection of patients based on component fit may increase survivorship seen in hybrid fixation. Further study, especially analysis of greater than 15-year survival, is warranted and would add considerably to the debate concerning the optimal method of fixation in primary TKA.

Table 1. Comparison of hybrid TKA results

Study	Hybrid	
	Survival (%)	Number
Rand et al., 2003 [40] (10 years)	84	172
Gioe et al., 2004 [19] (11 years)	93.2	837
Faris et al., 2008 (current study) (13 years)	97.3	201

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